Space Weather Technical Forecast

Issued on Thursday 13 February 2025 at 12:37 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1 to end UTC working week. Rising Chance of R1.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured by GOES16 rose to Moderate, with the peak flare an M1.0 at 13/1109UTC from AR3992 in the southwest. There are up to six sunspots on the current visible disc, although monitoring has been slightly degraded by a period of unavailability of HMI imagery, with NSO GONG used in its stead. The main group on the current disc is perhaps AR3992, which saw a strong growth trend from plage in the last 36 hours or so, currently appearing as a bipolar Zurich Dsi. The other potential sunspot region of note is perhaps then AR3990 in the southeastern quadrant, which has been more stable in terms of overall size, but shows a relatively large and asymmetric leading spot group in its Cko classification.

No Earth-directed CMEs were observed in available imagery. Imagery to determine any CME from the M1.0 flare is not yet available.

Solar Wind / Geomagnetic Activity: Solar winds, as measured at L1 by ACE, showed a waning connection to a negative polarity fast wind in the period - likely the fading of CH13/-, and perhaps a tenuous link developing into CH14/- later in the current UTC morning. Any segue from one to the other may be indistinct as the two features may form a continuum on the disc.

Solar wind speeds started Elevated at around 525km/s, but gradually waned to the mid-400s of km/s over the 24 hours, before a slight uptick by the period's end. The solar wind density was level within background of single figures ppcc. The IMF was also a background, on a slightly rising trend to a peak of 7nT, with a north-south component varying between +6 and -7nT. The phi angle was negative throughout.

The net result of the above solar wind measures was for provisionally Unsettled to Active geomagnetic activity, peaking at Kp '4+' in the 03-06UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 persisted at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was predominately High at first, reaching a peak of 2050pfu at 12/1745UTC before falling to Normal Background in the current UTC day. The

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associated 24-hour fluence persisted below the Active threshold, recording 7.64e7 integrated pfu at 13/0001UTC on a slightly declining trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity will most likely be Low, but with a daily Chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Current fast winds, either from CH13/- easing or the initial portion of CH14/-, are expected to become further enhanced in the remainder of day 1 and into day 2 (13-14 February), reaching Elevated to Strong speeds. These winds are likely to continue over the UTC weekend.

Initial Unsettled to Active geomagnetic activity should become Active with a Chance of G1 Minor Storms to end the current UTC working week, as CH14/- more fully connects with Earth. There remains a Slight Chance of G1 over the ensuing weekend as the fast wind matures.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to persist at Background levels. There is now a marginally increased Slight Chance of S1 as a result of the M1.0 flare late in the current reporting period.

High energy electron flux has shown some erosion at GEO in the past 24 hours from a previous Moderate to High oscillation, such that confidence in fluence levels nearing Active is now lower. Any recovery later in the period remains low confidence. The associated 24-hour fluence now carries a Slight Chance of reaching Active over the remainder of day 1 (13 February), with a now-reduced Chance into day 2 (14 February). Confidence then becomes low, but with a Slight Chance of Active fluence day 3-4 (15-16 February).

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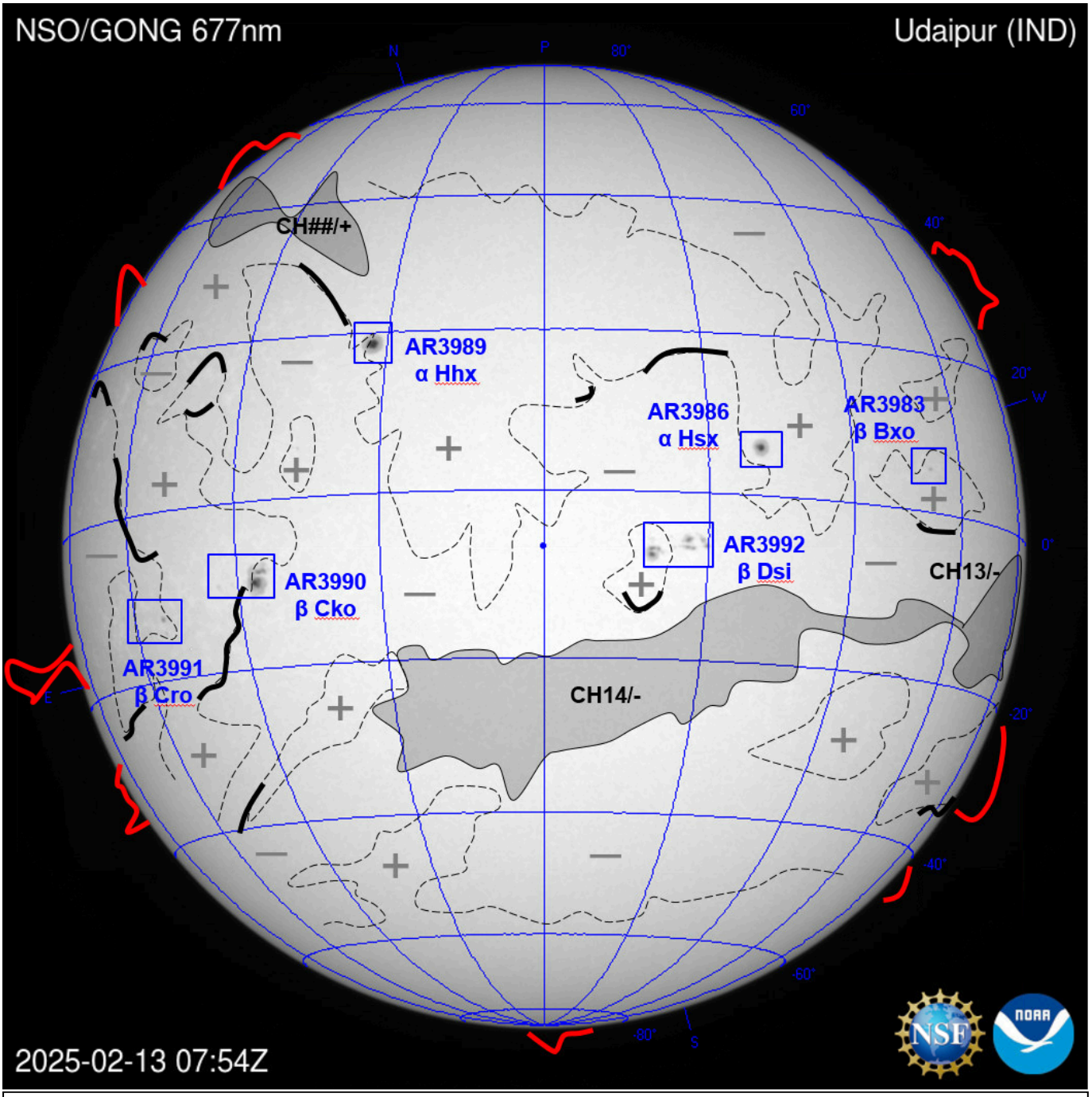
Figure 1: Latest MOSWOC Solar Synoptic Map, valid 13/0755UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no confirmed Earth-directed CMEs at the time of writing. The geomagnetic forecast comprises a gradual transfer from one fast wind to another.

Solar winds are currently slightly elevated, perhaps due to the tail end of CH13/-, but more likely from the initial connection to the fast wind from the narrow leading edge portion of CH14/-. Later day 1 (13 Feb) this is forecast to become further enhanced with the likely arrival of Elevated to Strong winds from the darker bulk portion of this feature, which extends over 50 degrees in longitude across the southern solar hemisphere. The onset of these winds could be preceded by a CIR region which could bring elevated geomagnetic activity, before transitioning into more typical high speed stream (HSS) conditions for the rest of the period. This feature is likely to be well-connected to Earth, given its negative polarity and Earth's current location south of the solar equator.

Unsettled to Active geomagnetic conditions should continue at first, with a Slight Chance of G1 Minor Storm intervals. These are Likely to become mainly Active with a Chance of G1 Minor Storm intervals by the end of day 1, and continuing into day 2 (13-14 February). As Earth moves through the HSS on days 3-4 (15-16 February), Unsettled to Active geomagnetic activity is expected to return with a reducing Slight Chance of G1 Minor Storm intervals.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	40	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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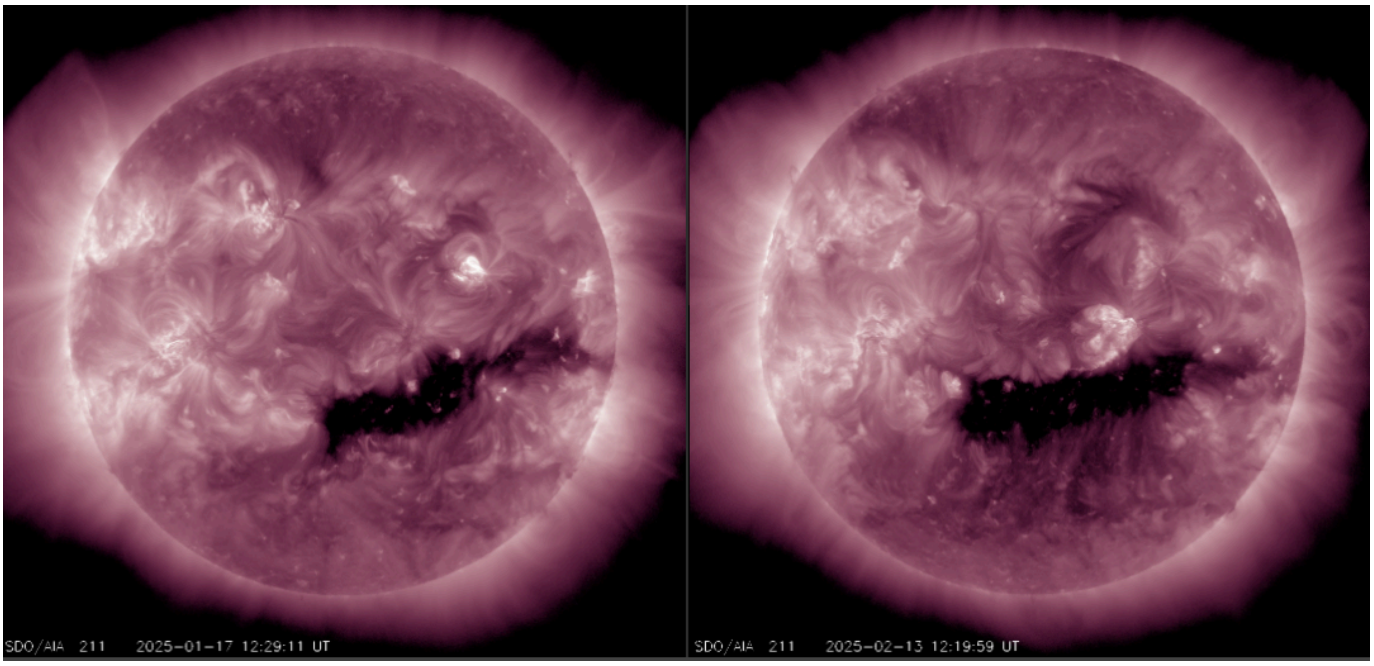
Figure 2: Past and current rotations' coronal holes in AIA211 imagery, showing some slight leading edge geometry changes. One of the main uncertainties is likely to be any separation between the two features given that they appear to be tenuously linked in this imagery.



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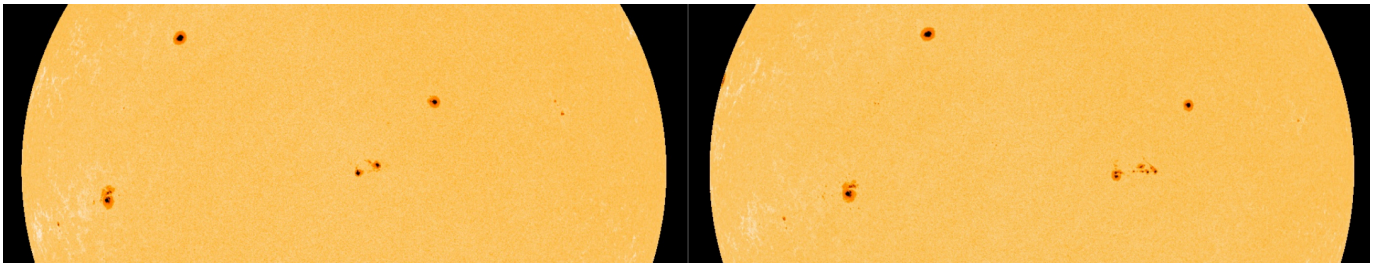
Radio Blackouts - X-Ray Flares

There is a maintained Chance of further isolated M-class flares, mainly due to AR3992's growth trend and potential to develop into a more complex region. This observed growth in AR3992 may now be bearing fruit as the latest 24-hour period has been capped by a late M1.0 flare.

Regarding the balance of front-sided groups, none that significantly contribute to the global flare risk leave the front side in the four days. As for arrivals, Ex-3973 is due inside the next 24 hours from over the eastern limb, and this has unusually remained relatively visible on far-side soundings despite nearing E090 (where the signal usually fades due to measurement limitations). EUV flux looping is now becoming visible in its expected location on AIA171 imagery for example, and the past 72 hours or so have seen CME candidates from its posited location - all of which point to a possible slight uptick in X-ray flare risk into the coming UTC weekend.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	40	50	50	50
Very Active	R3-R5 (X Class)	No	1	1	1	1

Figure 3: 12/1245UTC and 13/1245UTC HMIIF imagery of the current disc, highlighting the rapid growth of AR3992 in the south-centre in particular.



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is forecast to persist at background, with a daily Slight Chance of enhancement from any notable flares given the relative simplicity of the sunspot regions currently on the visible disc. There is now an additional risk factor of S1 for the remainder of day 1 - the possibility that AR3992's M1 flare at 13/1109UTC may yet produce an eventual enhancement at GOES - this should become known in the next few hours. Risks are otherwise near background.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 had been Moderate to High due to the now-fading connection to the fast wind of CH13/-, however the diurnal electron oscillation has shown some erosion in the past 12 hours or so at GEO under sustained Unsettled to Active geomagnetic activity. Confidence in fluence levels nearing Active is now lower than previously advertised, and any recovery at GEO later in the period remains low confidence due to uncertainties in the strength and duration of CH14/-. The latest MOSWOC REFM is now retreating on its previous thoughts of Active 24-hour fluence being realised in the immediate term, and this trend is accepted, with an overall downward tendency characterising the next 72 hours.

The associated 24-hour fluence now carries a Slight Chance of reaching Active over the remainder of day 1 (13 February), with a now-reduced Chance into day 2 (14 February). This Chance is maintained for now as it is unclear as to how permanent the current reduction is a GEO, and whether CH14/- has yet to more fully develop. Otherwise stated, the suppression already being seen at GEO may be sustained by further geomagnetic activity from any CIR region ahead of the stronger bulk region of CH14/-. Confidence then becomes low, but with a Slight Chance of Active fluence suggested for days 3-4 (15-16 February), with an uncertain magnitude of eventual recovery of fluence given what should be a protracted and restive geomagnetic environment.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	10	30	20	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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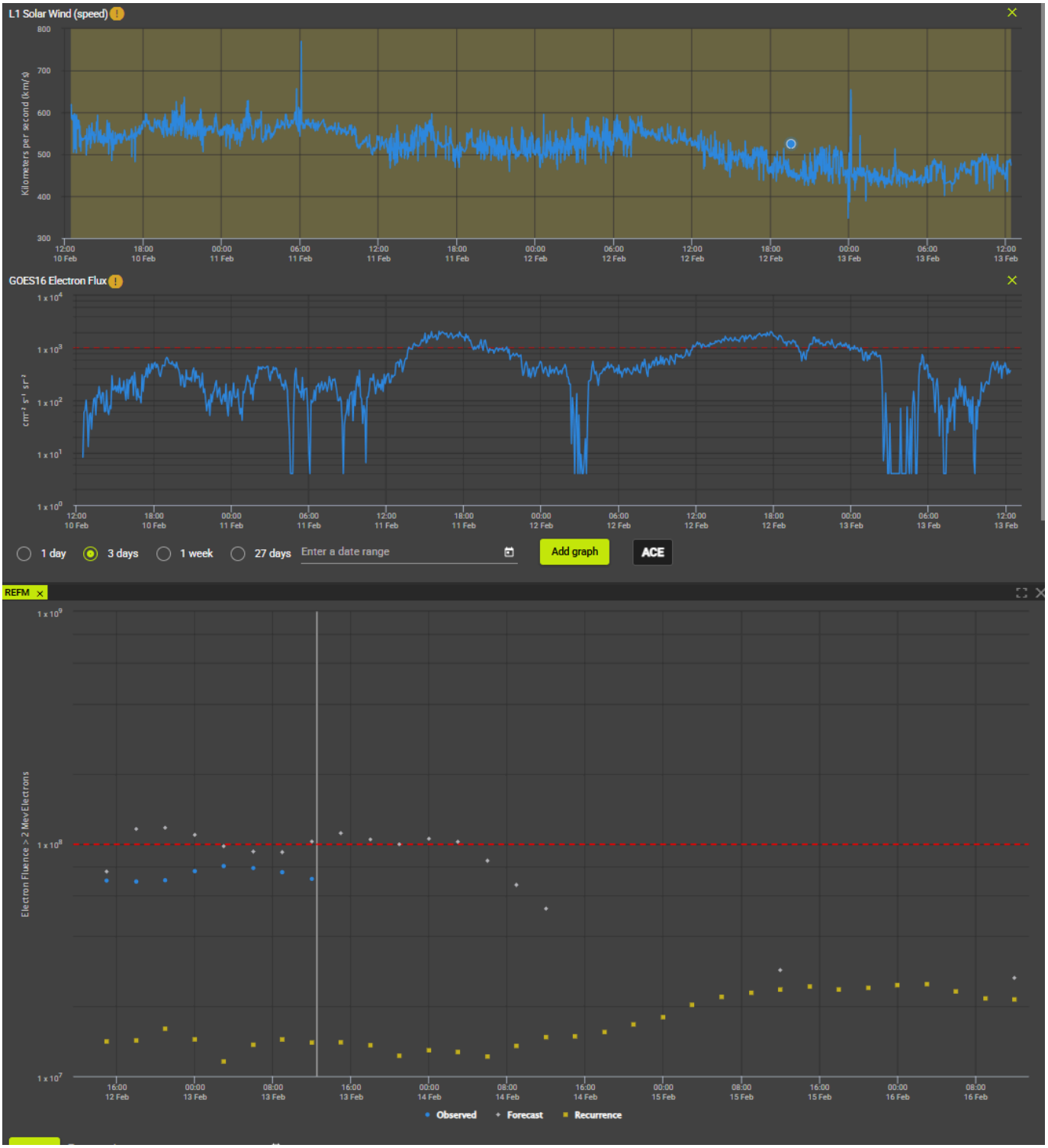
Figure 4: Past 72 hours in L1 solar wind speed at ACE, resultant GOES16 high energy electron flux at GOES16 and latest MOSWOC REFM output, as well as fluence observations. All traces are now waning slightly, which has led to a reduction in the risks of Active fluence in the near-term, although confidence later in the period remains low.



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